

REMARKS

Prior to this Amendment, claims 1-10 and 12-31 were pending in the application. Previously withdrawn claim 28 is cancelled with this Amendment.

Claims 8 and 16 are amended to correct minor typographical errors.

Independent claim 32 is added to provide further protection for Applicants' teachings with claim language that is distinct from the cited references. New claim 33 depends from claim 32 and is also added to further protect Applicants teachings.

Claim 1 is amended to clarify that all object allocated to a memory are first allocated to a Young Generation with their promotion to an Older Generation defined by which of two promotion policies are assigned to them during such allocation.

Independent claim 15 is amended to clarify that all objects are first allocated to the Young Generation – but assigned a first or second promotion policy for use in determining when (if) the object should be promoted to the Older Generation.

After entry of this Amendment, claims 1-10, 12-27, and 29-33 are pending for consideration by the Examiner.

Rejections of Claims under 35 U.S.C. §102

Claims 1-10, 12-26 and 29-31 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Pat. Appl. Publ. No. 2001/0044856 ("Agesen"). This rejection is traversed based on the following remarks, which begin with a discussion of Agesen's teaching and Applicants' teaching in general prior to proceeding to particular claim language. The discussion of claims begins with new independent claim 32, which the discussion of Agesen and Applicant's teaching should clearly provide reasons for finding this new claim allowable over this reference.

The Examiner cites paras. [0040] and [0041] of Agesen and these paragraphs provide a good overview of Agesen's teachings. Agesen explains that generational garbage collectors divide a memory heap into two or more generations, and objects are allocated initially into the first generation (or Young Generation in Applicants' language) with a single policy provided for promoting the longer-lived objects (see middle of paragraph [0040]) to the next generation (or Older Generation). Most collection work is performed in the youngest generation part of the heap. Hence, to increase garbage

collection efficiency, Agesen teaches in para. [0041] that "pretenuring" is one useful approach. In pretenuring, objects that are most likely to survive and be promoted from the younger generation part of the heap are identified. Instead of placing these into the younger generation at all pretenuring involves "allocating such objects directly in that generation" (emphasis added; see middle of para. [0041]). Agesen teaches that this technique of allocating directly to the older generation part of the heap is desirable because "by not allocating long-lived objects in younger generations, we reduce the number of collections in those generations" (again, emphasis added).

Applicants teach a very different technique for improving efficiency of memory allocation. It is so different that Agesen actually teaches away from Applicants' claimed invention. Specifically, in Applicants' Summary paras. [0010] and [0011], it is explained that conventional garbage collectors "promote all objects in the Young Generation in accordance with a single policy" (as was also taught by Agesen as noted above), and, unfortunately, this results in "premature promotion of some objects that become garbage after they have been moved to the next generation." Agesen, in effect, teaches premature promotion by simply skipping any allocation of certain objects to the younger generation by placing them directly into the older generation, and Applicants have argued that this is often undesirable. Specifically, para. [0011] indicates that there are several drawbacks to promoting objects to the older generation. Such promotion is more expensive to garbage collect, and it may result in unnecessary use of the space reserved for the older generations.

As discussed in paras. [0013] to [0015], Applicants teach that premature promotion can be avoided by using information about an object to determine if the object should be assigned a normal/conventional promotion policy or a different promotion policy that delays (or even prevents) promotion for that object to an older generation. Note, such assigning of the promotion policy is chosen upon allocation to the young generation portion of the heap/memory (such as by using the general memory allocator or a preemptive memory allocator). However, all objects in Applicants' method are first assigned to the young generation, which is in direct contrast with the teaching of Agesen. Agesen, instead, teaches a form of a preemptive memory allocator that allocates select objects directly to an older generation (e.g., based on

statistics gathered over time to define which types of objects may prove to be long lived objects). Applicants are taking a very different approach (basically, the opposite approach shown by Agesen) by trying to determine which objects are more likely to be or quickly become garbage (e.g., don't want to promote an object that may live 5 cycles when the promotion threshold for the garbage collection counter is 4 cycles as this is inefficient).

Turning now to claim 32, this method is directed toward a computer readable storage medium with code that allocates "all of the objects into said Young Generation."

As discussed above, Agesen fails to show such a method of allocating but instead teaches determining based on statistical analysis a subset of the objects that are not allocated first to a young or initial generation but instead are allocated directly into an older generation of the heap/memory. Hence, for this reason alone, Agesen cannot be said to anticipate claim 32 (and teaches away from its implementation as such allocation of all objects to the Young Generation would destroy the intent and effectiveness of Agesen's method).

Further, claim 32 calls for the objects allocated to the Young Generation to be promoted after placement in the Young Generation based on differing promotion policies, and Agesen does not discuss any different treatment of objects after they are placed into the heap (and, particularly, not into the Young Generation). Clearly, Agesen does not show that some objects should have their tenure in the Young Generation extended or be longer than normal as its entire teaching is in selecting longer lived objects and not shorter lived objects that should not be promoted (e.g., even if Agesen did teach differing promotion policies – which it doesn't as it teaches differing direct allocators – it would like teach a preemptive promotion policy that shortens rather than lengthens tenure for long lived objects). For this additional, reason claim 32 is not anticipated by Agesen.

Further, claim 32 calls for code for promoting live ones of the objects allocated in the Young Generation to the Older Generation including first determining which promotion policy had been assigned to the object and then applying this promotion policy. As noted above, Agesen fails to teach or suggest differing promotion policies but only discusses differing direct allocation of objects (but then similar treatment of all

objects once they are in the heap with a garbage collector). For this additional reason, claim 32 is not anticipated by Agesen.

Claim 33 depends from claim 32 and is believed allowable over Agesen for at least the reasons provided for allowing claim 32 over this reference. Further, claim 33 calls specifically for the first promotion policy to assign a value to a garbage collection count and for the second promotion policy to involve assigning a pre-emptive count value to the object that defines the longer tenure for the object in the Young Generation. Agesen does not teach assigning a pre-emptive count value to any of its objects, and this is due, in part, to the fact that this reference does not define longer tenures for objects first allocated to a Young Generation. For this additional reason, claim 33 is not anticipated by this reference.

As amended, claim 1 includes limitation similar to those found in claim 32 but in method form. Hence, the reasons for allowing claim 32 are applicable to claim 1.

Further, claim 1 requires that an indication be provided in the header of the object to identify to a promotion method when the first (or normal) promotion policy is preempted (see, for example, the preemption indicator 212 or 222 in Figures 2C and 2D of Applicants' specification and their use in step 404 of method 400 of Figure 4). The Office Action in the Response to Arguments indicated that this limitation was shown in a prior rejection of claim 11 (which was cancelled). In that prior rejection, the Examiner had cited Agesen in paras. [0087] and [0101]. In para. [0087], Agesen uses overflow of an allocator "as a criterion for selection of a sampled subset." There is no discussion of inserting any indication within a header of an object in this paragraph, and, again, Agesen fails to show using differing promotion policies so it would not show providing an indication relative to multiple promotion policies. Para. [0101] discusses object lifetime statistics that may be useful for determining which objects should be allocated directly into an Older Generation but provides no discussion of an object header or of providing an indication of which promotion policy has been assigned to the object in a header. Hence, Agesen fails to show the method of claim 1 for this additional reason.

Claims 2-10 and 12-14 depend from claim 1 and are believed allowable over Agesen at least for the reasons provided for allowing claim 1 over this reference.

Independent claim 15 as amended includes limitations similar to those found in claim 32 and is believed allowable over Agesen at least for the reasons provided for allowing claim 32. Further, claim 15 includes a limitation that the second promotion policy (which causes a delay or cancellation of the promoting of an object) is assigned when the objects are allocated by system code or are associated with operations that are known or defined as likely to generate garbage. Agesen, as discussed above, uses statistical analysis to determine which objects are long lived – and, hence, not garbage.

Claim 15 calls out the opposite step of assigning objects that are more likely to be or become garbage a promotion policy that slows or blocks their promotion. There is no similar teaching in Agesen, which appears to treat all objects similarly once they are allocated in either a young generation or directly into an older generation. For these additional reasons, claim 15 is believed in allowable over Agesen.

Claims 16-26 depend from claim 15 and are believed allowable over Agesen at least for the reasons provided for allowing claim 15 over this reference.

Independent claim 29 is directed to a computer readable storage medium with limitation similar to those found in claim 1, and it is believed allowable for the reasons provided for allowing claim 1 over Agesen. Claims 30 and 31 depend from claim 29 and are believed allowable over Agesen at least for the reasons provided for allowing claim 29 over this reference.

Rejections of Claims under 35 U.S.C. §103

Additionally, in the Office Action, claim 27 was rejected under 35 U.S.C §103(a) as being unpatentable over Agesen in view of U.S. Pat. Appl. Publ. No. 2003/0187888 (“Hayward”). Claim 27 depends from claim 15 and is believed allowable over Agesen at least for the reasons provided for allowing claim 15 over this reference. Further, Hayward fails to overcome the deficiencies of Agesen with regard to claim 15. Hence, the combined teaching of the two cited references fails to suggest the computer system of claim 27.

Conclusion

In view of the above amendments and remarks, Applicant submits that all claims are clearly allowable over the cited prior art.

No fee is believed due with this Amendment. However, please credit any overpayment or charge any underpayment to Deposit Account No. 50-1419.

Respectfully submitted,

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